GPG347

Good Practice Guide

Installation and commissioning of refrigeration systems

ACTIONenergy

CARBON TRUST

Making business sense of climate change

Introduction

This guide is for you if you install or commission refrigeration equipment because you affect the energy consumption and running costs of the plant you install or commission.

This guide shows what effect you have and what you can do to reduce the running costs of the refrigeration equipment you install or commission.

Installation

The way a system is installed is important. A clean, leak-tight system with minimum pipeline pressure drop will not only be energy efficient, but also reliable.

Commissioning

The commissioning process has a big impact on how efficiently a system runs. It must be clean, dry and correctly charged to operate efficiently. Controls should be set so that the evaporating temperature is as high as possible and the condensing temperature as low as possible.

You

It is assumed that you already have a good working knowledge of refrigeration. There is a simple explanatory diagram of the efficient operation of a simple refrigeration system on page 4, but if you want to know more then Good Practice Guide 280 – Energy efficient refrigeration technology – the fundamentals, is a good starting point.

This guide will not teach you everything about installation and commissioning - it highlights the practices which affect refrigeration system efficiency. It will help you to help your customer save money. An efficient system is usually a reliable one. If you service the systems you install and commission, this will benefit you and your business.

Reducing refrigeration system energy use is not rocket science – most technicians have the necessary skills, tools and equipment. This guide shows you how to use them effectively to save money for your customers and enhance your commercial image.

The cost of using electricity

Refrigeration and air conditioning systems in the UK use nearly 11% of the total power we produce. This currently costs users about £350 million a year. This cost increased, typically by 15%, from April 2001 with the introduction of the Climate Change Levy – **a tax on energy**.

Not only is electricity expensive, generating it also damages the environment. We produce most of our electricity by burning coal, gas or oil, which give off carbon dioxide - a "greenhouse gas". Carbon dioxide is one of the causes of undesirable climate change. Other powerful greenhouse gases include refrigerants – CFCs, HCFCs and HFCs.

- Directly if CFC, HCFC or HFC refrigerants are leaked or vented to atmosphere
- Indirectly through the use of electricity.

Users of refrigeration equipment are becoming more committed to reducing energy consumption for two reasons:

- To reduce direct costs and therefore increase profits
- To improve environmental performance and therefore improve their "green" image.

How can you help?

As an installation or commissioning engineer you can help your customers reduce their refrigeration plant running costs and improve their environmental performance. Many refrigeration systems take more power than they need to because they are poorly installed and commissioned.

Of course, other people also affect energy efficiency, including the system designer and the user. At the end of this guide there is a list of energy efficiency publications for everyone involved with refrigeration equipment – see page 19.

The Greenhouse Effect

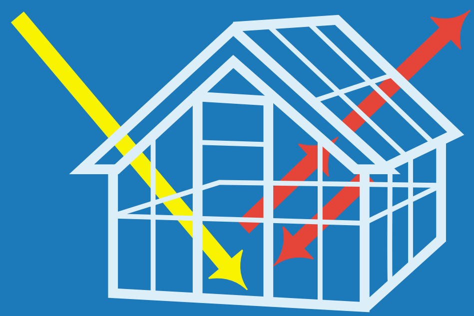


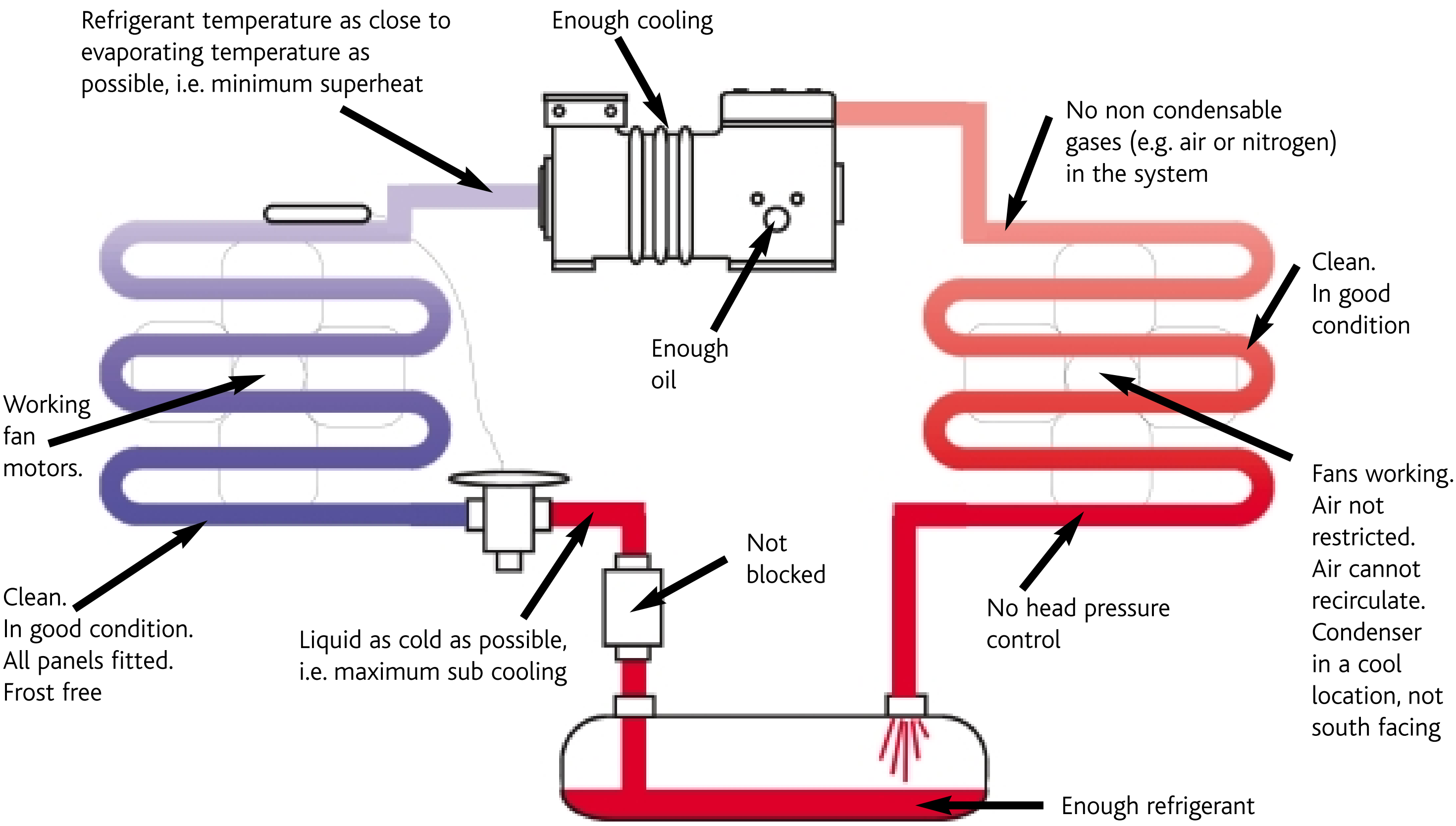
Diagram courtesy of the Met Office's Hadley Centre for Climate Prediction and Research. ©Crown copyright, Met Office. Reproduced under Licence Number MetO/IPR/2/2003 0024.

The Greenhouse Effect

A balance between energy coming in from the sun in the form of visible radiation (sunlight) and energy constantly being emitted from the surface of the earth to space determines the temperature of the earth. The energy coming in from the sun can pass through the atmosphere almost unchanged and warm the earth, but the infrared radiation emanating from the earth's surface is partly absorbed by some gases in the atmosphere and some of it is re-emitted downwards. This further warms the surface of the earth and the lower atmosphere. The gasses that do this naturally are mainly water vapour and carbon dioxide. An analogy is made with the effect of a greenhouse, which allows sunshine to penetrate the glass that in turn keeps the heat in, hence the greenhouse effect.

Without this natural greenhouse effect, the earth would be over 30˚C cooler and would be too cold to be habitable. But as greenhouse gas concentrations rise well above their natural levels, the additional warming that will take place could threaten the future sustainability of the planet.

Energy efficient refrigeration systems



The temperature lift is the difference between the condensing temperature and the evaporating temperature. It is a measure of how hard the system has to work.
A reduction in temperature lift of 1°C reduces running costs by between 2% and 4%.
In other words:

- Increasing the evaporating temperature by 1°C reduces running costs by 2 to 4%.
- Reducing the condensing temperature by 1°C reduces running cost by 2 to 4%.

How you can improve efficiency

The factors that affect efficiency are to do with:

- **The refrigeration load** (e.g. the heat gains into a cold store or cabinet), which should be as low as possible;
- **The temperature lift** (difference between condensing and evaporating temperatures) which should also be as low as possible; or
- **Superheat**, which should be as low as possible, and **subcooling**, which should be as high as possible.

The tables below show the things that you have control over, and how you can improve the efficiency of many of the systems you work on. The starred factors are the ones that usually have the biggest impact on energy consumption.

Load – keeping it as low as possible (these relate mainly to cold stores and cabinets)

Load Factors	Can you affect this?
***Air change loads** through cold store and cabinet doors or through cabinet lids.	**Yes** • ensure doors and lids fit well; • when you fit door strips, make sure they cover the whole door opening, and that they overlap; • when you fit night blinds, ensure the gap at each end is less than 1.5cm, otherwise warm air is drawn into the cabinet; • advise on the importance of effective cold store door management to minimise door opening time.
Heat gains into a cooled space or product.	**Yes** • construct cold stores so that all panels/joints are sealed; • ensure cabinet sections are sealed; • insulate secondary refrigerant pipe work.
Occupancy, e.g. through people and machines.	**No**, but you can advise on how to keep it to a minimum.
Ancillaries such as evaporator fan motors, defrost, in line coolers in beer cellars and secondary refrigerant pumps contribute twice to energy costs. They use electricity directly and also heat the cooled space or fluid, increasing the load.	**Yes** • make sure the system does not defrost for longer or more often than necessary; • on multi-fan air coolers, set the controller to switch off all but one evaporator fan motor when the refrigeration system is not needed.
Loading of product.	**No**, but you can advise on good product loading in cold stores and cabinets so that air flow is not obstructed.
Suction line heat gains.	**Yes** • insulate all suction lines.

Temperature lift – keeping the evaporating temperature high and the condensing temperature low

Temperature Lift Factors	Can you affect this?
***The condenser** – it should be as clean as possible, with unrestricted air/water flow.	**Yes** • make sure air is not restricted or recirculating (air cooled condensers); • position the air on face out of direct sunlight (air cooled condensers); • check that all fans are working and rotating in the right direction.
***The evaporator** should be as clean as possible with a minimum of frost build up.	**Yes** • position evaporators so that the air is not restricted; • set the defrost system so that defrost is frequent enough with a long enough duration to minimise frost build up; • check that all fans are working and rotating in the right direction.
***A refrigerant** shortage reduces the evaporating pressure and/or forces the compressor(s) to run for longer.	**Yes** • install the system to reduce the possibility of leakage – use as few joints as possible, and braze them; • strength and leak test the system thoroughly before charging with the correct amount of refrigerant.
Air and other non condensable gases in the system which increase the condensing pressure.	**Yes** • evacuate the system thoroughly prior to charging (to remove air and nitrogen); • take care not to charge air into the system.
Head pressure control keeps the condensing pressure high.	**Yes** • if head pressure control is used, set the pressure as low as possible whilst maintaining the high side pressure in the required range.
Excessive refrigerant charge backs up in the condenser and increases the head pressure.	**Yes** • do not charge too much refrigerant into the system.
Pressure drops, especially in the suction and liquid line, increase the compression ratio of the compressor, reducing its efficiency.	**Yes** • use swept bends in place of fittings; • route pipe work to minimise pressure drops by keeping pipe runs as short as possible and bends to a minimum.
Incorrectly set controls (e.g. thermostat or low pressure switch) force the system to operate at lower evaporating pressures than necessary.	**Yes** • make sure that controls are correctly set. This can be as simple as adjusting the thermostat setting so the product or secondary refrigerant is not too cold; • where evaporator pressure control is used, make sure it is set as high as possible.

Superheat and subcooling

Superheat & Subcooling Factors	Can you affect this?
Suction superheat should be as low as possible, while ensuring superheated gas returns to the compressor.	**Yes** • do not set the expansion valve superheat too high – usually 5K superheat (5°C temperature difference between evaporating and evaporator outlet) is sufficient to prevent liquid return to the compressor; • insulate the suction line.
Liquid subcooling should be as high as possible.	**Yes** • insulate the liquid line if it passes through an area of high ambient temperature (e.g. the inside of a supermarket), or if the liquid refrigerant is subcooled, e.g. by an economiser; • where multiple evaporators are used on one system (e.g. a supermarket system) ensure the liquid lines are sized and routed so that one or more evaporators are not starved of refrigerant; • if the liquid line has a high vertical lift check that the pressure drop from this has not caused flash gas in the liquid going into the expansion valve.

The following sections show how you can apply the recommendations in the tables above when you install and commission equipment.

Siting and installing the equipment

Put the equipment in the best place

The position of equipment is usually determined by the project engineer, but you can make sure:

- There is good access to equipment for installation, maintenance and servicing. If it is difficult to get to, it is less likely to be properly maintained
- There is unrestricted air flow to air cooled condensers, evaporative condensers and cooling towers
- Condenser air on faces are out of direct sunlight
- Air cannot recirculate around air cooled condensers.

Get component installation right first time

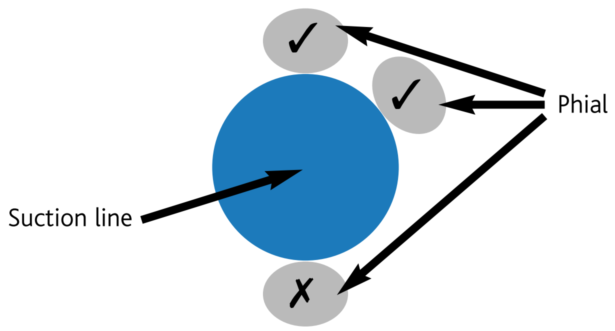
Component manufacturers' instructions should be followed when installing the plant, but general guidelines are:

- Make sure compressors are level and mounted on vibration eliminators (e.g. springs) where necessary. Remove transportation blocks from compressor mountings if necessary

- If a housing is to be fitted to a condensing unit, make sure it is a good fit and does not restrict the air flow or allow the air to recirculate. If there are gaps between the air on face of the condenser and the housing, air will recirculate – block these gaps up

- Install water cooled condensers so that there is access to clean the tubes. If the maintenance engineer can't clean the condenser, it will gradually foul up and the condensing pressure will rise, reducing system performance

- Fit expansion valves as close to the evaporator inlet as possible and fit the controlling phial to a horizontal section of pipe at the exit of the evaporator. Do not mount the phial below the suction line – if you do the valve will not control properly (see diagram for correct locations).



If the phial has to be fitted to a vertical length of the suction line, ensure the capillary tube is at the top of the phial so the refrigerant in the phial does not drain out;

- Always insulate the phial and use the clamping strip provided by the manufacturer – do not use plastic cable ties or anything else which will not transfer heat from the pipe into the phial

- When using externally equalised valves, ensure the equalising line is connected to the top of the suction line so oil cannot drain into the line

- Ensure evaporator defrost heaters can be removed if necessary (i.e. heater failure is not uncommon so there needs to be sufficient space between the end of the evaporator and a wall to replace them. If the evaporator does not defrost correctly it is much less effective.)

- Evaporator drain lines (where fitted) should allow defrost water to drain away easily and should be heated and insulated in rooms below 0°C. If not they freeze up so the melted frost cannot drain away causing worsening ice build up

- Evaporators in cold stores should not be located close to, or directly opposite, doors, otherwise a lot of cold air is lost whenever doors are opened and there will be a significantly greater degree of frost build up on low temperature evaporators

- Insulate suction pipe work between the evaporator and the compressor to reduce non useful heat pick up which reduces compressor performance. Whenever possible, avoid routing suction lines through or close to hot areas

- Ensure plant rooms have adequate ventilation. An extraction fan may be needed, in which case there should also be adequately sized louvered panels for inlet air. Where condensing units are located in plant rooms, the louver size should be 1.5 times the condenser air on face area

- Cold store and cabinet panels should be properly sealed to prevent heat leakage and insulation degradation. Doors and lids should seal properly when closed

- Where automatic door controls are used, the timer should be set to minimise the opening time while still providing adequate and safe access

- Refrigerated cabinets should be level and away from draughts from air conditioning units, ventilators, doors and sources of heat (including solar radiation through windows). Integral type appliances need cooling air and must therefore not be placed too close to walls etc. and will need good ventilation.

Keep components clean

If dirt gets into components it blocks valves and filters and increases running costs. A vacuum pump won't remove this dirt. Keep components and pipes sealed until you're ready to install them. This will also reduce the amount of moisture from the air that gets into the system, saving you time when you evacuate the system.

Pipe work

Reduce leakage potential

Refrigerant leakage causes the system to work harder and longer and is one of the main reasons for an increase in electricity consumption. You can reduce the risk of leakage by:

- Keeping the number of joints to a minimum
- Brazing joints – you should not use hand made flared joints. If necessary you can use machine made flares
- Using flexible hose to connect pressure switches
- Supporting pipe work correctly with the right spacing between supports as shown below.

Tube type	Size, mm (ins)	Spacing, m (ft)
Soft copper	15 to 22 (OD) ($^1/_2$ to $^7/_8$)	1.0 (3)
Half hard copper	22 to 54 (OD) ($^7/_8$ to $2^1/_8$) 54 to 67 (OD) ($2^1/_8$ to $2^5/_8$)	2.0 (6) 3.0 (10)
Steel	15 to 25 (NB) ($^5/_8$ to 1) 32 to 50 (NB) ($1^1/_4$ to 2) 64 to 85 (NB) ($2^3/_8$ to $3^1/_4$) 100 to 175 (NB) (4 to 7) 200 to 350 (NB) (8 to 14) 400 to 450 (NB) (16 to 18)	2.0 (6) 3.0 (10) 3.5 (11) 4.0 (13) 6.0 (19) 7.5 (24)

- Installing primary vibration eliminators ("anacondas") parallel to the compressor shaft. Install secondary eliminators at right angles to the primary. Do not install vibration eliminators vertically as ice build up is more likely to cause damage than when the eliminator is horizontal.

Keep pipes clean

Pipe should always be cut using a proper pipe cutter or chain cutter, never a hacksaw.

When brazing joints purge a small amount of dry nitrogen through the pipe work to eliminate air. This prevents oxides building up on the inside of the tube which can later block filters and valves and damage compressors.

Only a small flow of nitrogen is needed. The most convenient arrangement is to pass nitrogen into the pipe work through a fitting located at one end of the pipe section, as shown in the main photo. Fit a cap with a small hole in at the other end of the pipe section, as shown in the inset photo. Open the regulator on the nitrogen to give a low flow – you should only just feel the flow on your hand through the hole in the cap. You can reuse the cap and fitting. Alternatively, use a plastic cap with a hole sized for a $^{1}/_{4}$" line. Always use oxygen free nitrogen (ofn), also known as "white spot" nitrogen.

The image shows opened out joints in copper pipe. The left hand one was made with dry nitrogen and the other without. The image clearly shows the amount of contamination on the inside of the pipe when you braze without nitrogen. This will later clog up filters and the expansion valve orifice, reducing the system performance.

Reduce pressure drops

Some pressure drop is unavoidable, but high pressure drops make the compressor work harder and for longer, increasing running costs. You can minimise pressure drops in pipe work by:

- Keeping pipe runs as short as possible
- Pull swept bends in the pipe instead of using right angle fittings (as well as imposing a lower pressure drop, this will also be quicker, produce fewer joints and be easier to insulate)
- Use the largest possible pipe diameter, while ensuring the refrigerant velocity is high enough to get the oil back to the compressor.

Insulate pipe work

Insulation is needed to reduce undesirable heat picked up in the refrigerant. You must insulate:

- All suction lines between the evaporator and the compressor inlet
- Liquid lines where economisers or subcoolers are used (after the economiser or subcooler)
- Liquid lines where the temperature surrounding the liquid line will be above the condensing temperature (insulate the liquid line where it is in the higher ambient area, not where it is outside). This will be the case when the liquid line passes inside a heated building such as a supermarket, unless the head pressure control is set very high
- Saturated/hot gas defrost lines

Insulation should be cut to length and joined using the correct glue and tape:

- Make sure the insulation is clean before fixing it
- Use a sharp knife and follow the adhesive instructions to ensure you make a reliable joint
- Do not pull joints – push them together
- Insulate the pipe work before the system is started – the adhesive will be more reliable if used at ambient temperature rather than extremes of temperature.

Strength and leak testing and evacuating systems

Check for strength and leakage

To comply with the Pressure Equipment Regulations, systems must be pressure tested for strength. They should also be leak tested. Both tests should be carried out by carefully pressurising the system with an inert non hazardous gas such as dry nitrogen to a pressure above the maximum allowable pressure of the system (Ps). Do not use oxygen for pressure and leak testing – it is dangerous and can explode when it comes into contact with the compressor oil.

It is recommended that:

- The strength test pressure is between 1.0 and 1.3 x Ps
- The leak test pressure is between 1.0 and 1.1 x Ps.

The strength test pressure must always be higher than the leak test pressure.

Ps for the high side of the system will often be different for Ps for the low side. This information should be provided by the system designer.
If it is not, the table below gives typical test pressures when the maximum ambient is 32°C.

To check for strength the system should be pressurised at the test pressure with dry nitrogen (oxygen free nitrogen, white spot nitrogen). The length of time the system is held at the test pressure depends on the size of the section of the system under test. A large system with long pipe runs will need to be tested overnight. You will be able to hear obvious leaks, or you will see the pressure gauge on the nitrogen regulator drop.

To check for smaller leaks each joint should be checked, e.g. with soapy water (i.e. washing up liquid and water) or a leak detection fluid. If you want to use an electronic leak tester for this, then a trace of refrigerant needs to be added with the nitrogen charge.

A vacuum test is not usually a sufficient test for leakage.

Components such as compressors, condensers, evaporators and liquid receivers, which have already been pressure and leak tested by the manufacturer, do not need to be re-tested on site unless they have lost their holding charge. You do need to check the connections that have been made to these components.

Refrigerant	Max condensing pressure, bar g*	Max still pressure, bar g	High side strength test pressure, bar g	High side leak test pressure, bar g	Low side strength test pressure, bar g	Low side leak test pressure, bar g
R134a	11.3	7.2	11.3 to 14.7	11.3 to 12.4	7.2 to 9.4	7.2 to 7.9
R404A	20.7	14.1	20.7 to 26.9	20.7 to 22.8	14.1 to 18.3	14.1 to 15.5
R407C	19.5	13.5	19.5 to 25.4	19.5 to 21.4	13.5 to 21.5	13.5 to 14.8
R410A	28.8	11.8	28.8 to 37.4	28.8 to 31.7	11.8 to 15.3	11.8 to 13.0
R290	15.0	10.5	15.0 to 19.5	15.0 to 16.5	10.5 to 13.6	10.5 to 11.5

* This is based on a condensing temperature of 47°C at the maximum ambient.

Ensuring good evacuation

- Make sure the connection to the system from the vacuum pump is tight – if these connections leak you will never be able to evacuate the system properly
- Make sure all the valves (e.g. solenoid valves) on the system are open so you evacuate the whole system
- Open the gas ballast valve on the vacuum pump when you start evacuating, this will increase the flow rate. You should close it again to achieve a deep vacuum
- To reduce the time needed to dehydrate a system you can use triple evacuation – break the vacuum each time with dry (oxygen free) nitrogen (do not use refrigerant for this)
- Close the valve to the vacuum pump before you switch it off to prevent vacuum pump oil contaminating the system.

System evacuation and dehydration

A vacuum pump removes moisture and non condensable gases such as the nitrogen used for the strength and leak test. Good evacuation is essential if the system is to operate reliably and at optimum conditions.

A two stage vacuum pump should be used - you will not achieve the required level of vacuum with a single stage pump. The system compressor should never be used as a vacuum pump – they are not designed for this purpose and will not reach the required vacuum.

For HFC refrigerants (e.g. R134a, R404A, R407A, R410A) you need to achieve a vacuum of 100 microns. This is equivalent to 29.916ins vacuum, 0.13mbar, 0.1Torr, 0.1mm Hg.

The vacuum should be measured using a proper vacuum gauge connected to the system, not the vacuum pump. A compound pressure gauge cannot accurately indicate the required level of vacuum.

The length and size of the hoses connecting your pump to the system effect the time it takes to evacuate the system:

- Evacuation will be 4 times as fast with $^3/_8$" hoses instead of $^1/_4$" hoses
- Evacuation will be twice as fast with a 1m hose as opposed to a 2m hose.

Make sure you change the vacuum pump oil regularly, especially if the pump is also used to evacuate older (contaminated) systems.

Charging refrigerant

Get the right amount in

The system must be charged with the correct amount of refrigerant to operate reliably and efficiently. If there is too little refrigerant the system will have to work harder and longer, resulting in a drop in efficiency. If the system is overcharged the head pressure may be too high, also reducing capacity and efficiency.

Systems fitted with a liquid receiver can hold a large "buffer" of refrigerant before being technically overcharged (i.e. to the extent that liquid backs up in the condenser). You should keep this buffer as small as possible while ensuring there is enough refrigerant to meet all load and ambient temperature conditions.

For an accurate charge:

- Charge by weight if you know what this should be. The system designer can work this out for you, but rarely does
- Charge to a full sight glass, but be aware that bubbles in the sight glass can also mean that there is a blockage in the liquid line, that the condenser is significantly undersized or the system is over condensing due to faulty or incorrectly set head pressure controls. If the sight glass is on the condensing unit or pack and there is a long or heated liquid line, a clear sight glass will not necessarily indicate clear liquid at the expansion valve
- If there is no sight glass before the expansion valve, charge until the right liquid temperature is achieved. The best way of checking this is to measure the liquid temperature at the expansion valves. If it is below the condensing temperature it is pure, subcooled liquid. You can calculate the condensing temperature by measuring the high side pressure and converting this to temperature using a comparator.

With the second and third methods described, the system will need to be at full load with the maximum condensing pressure.

Charging blends

When charging a zeotropic blend (e.g. R404A, R407C, Care 30) it must be removed from the cylinder as a liquid to maintain the correct blend composition. If you take the refrigerant out of the cylinder as a gas the pressure in the system will be higher than expected and the compressor may be overloaded.

Charge pure refrigerant

If refrigerant is contaminated with air the condensing pressure will be higher than necessary. Purge or evacuate charging lines to eliminate this possibility.

Setting controls

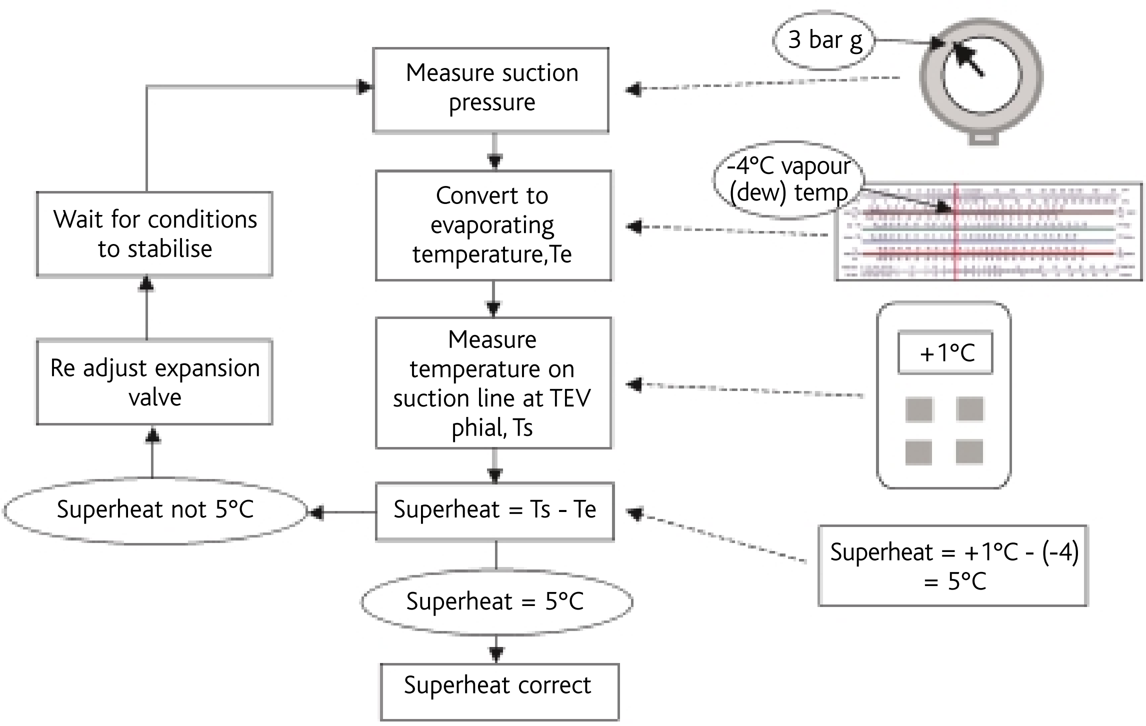
Various controls and safety devices will need to be set during commissioning. The overall aim is for safe operation, with the maximum possible evaporating pressure and minimum condensing pressure. When setting electro-mechanical controls such as pressure switches and thermostats don't rely on the indicator scale. This is rarely accurate. You should set the switches using a calibrated pressure gauge or thermometer. A controls pump that connects via a pressure gauge to the switch and simulates operating pressures can be used to enable accurate and simple pressure switch setting.

Set expansion valves

Expansion valves are factory set, but the setting will not always be the optimum for your system. If the superheat is too high the efficiency of the system will be reduced because the evaporator is not being used as effectively as it could be. If the superheat is too low (e.g. below about 4K) there is a risk that liquid can return to the compressor when the load changes.

The expansion valve superheat should usually be set to about 5K, i.e. the temperature of the gas leaving the evaporator should be 5°C higher than the evaporating temperature. When the refrigerant is a zeotropic blend the dew (vapour or gas) temperature should be used as the evaporating temperature.

Chart showing expansion valve setting procedure | **Example with R407C**



The superheat can only be accurately measured and set on a system that is working and that is fully charged. You will need an accurate gauge to measure evaporating pressure, a refrigerant comparator or tables showing the pressure temperature relationship, and a temperature probe to measure the temperature at the exit of the evaporator adjacent to the valve phial.

Set system controls

This may just involve setting one thermostat and the high pressure (HP) / low pressure (LP) switch. For more complex multi compressors installations various HP and LP switches or even a microprocessor control might be employed. All these controls require accurate setting. A good understanding of the control strategy and design criteria is essential. Whichever control is used, remember that for every 1°C reduction in evaporating temperature the power consumption increases by between 2 and 4%. So you should aim to set these controls as high as possible while still maintaining the desired product/space conditions.

For multi compressor systems and/or systems with compressors which have inbuilt capacity control, you should always aim to minimise the time any compressor operates on reduced load. This will always be less efficient than running at full load. The most efficient way to reduce the load on a system is to switch compressor off.

Set HP and LP switches

High and low pressure switches should also be checked and adjusted if necessary. The high pressure safety switch should not allow the system to operate above the maximum allowable pressure of the system (Ps). The low pressure switch (including those used to control a pump down) ideally should not allow the system to operate on a vacuum (unless the system is designed to operate at pressures below atmospheric). Mark all pressure switches with the set and differential settings.

Set head pressure control

Head pressure controls should be set as low as possible whilst maintaining the intended conditions, i.e. they should allow the head pressure to float as low as possible. On most systems the head pressure needs to be set no higher than 6 bar (90 psi) higher than the suction pressure.

Set up defrost

Ideally defrost on demand systems should be used as these defrost evaporators when necessary and for the required length of time. Defrosting will therefore always be right for the degree of frost build up. Where a timer system is used, the timers should be set for average frost build up. The system should defrost before the frost build up is severe enough to significantly reduce the evaporating pressure. The defrost period should be long enough to just clear the coil – any longer and a lot of heat will enter the cooled space. If the period is not long enough, the frost build up will worsen at each cycle.

With electric defrosting ensure the schedule does not overload the site electrical system by allowing multiple systems to defrost simultaneously.

Before you hand over the system

Check the system

You should monitor the system to check that it is running correctly:

1. Run the plant until the required evaporating temperature is achieved. Raise the condensing pressure to the maximum ambient condition and maintain this until the plant is cycling normally to ensure the plant operates correctly at maximum ambient conditions.

2. If possible, place heaters equal to the maximum load in the refrigerated space. Ensure the plant can achieve the required evaporating temperature at maximum load.

3. Check operating conditions and motor current draw against specification.

4. If the plant has a defrost system, run through a complete defrost cycle to ensure the correct termination temperature is achieved within the maximum defrost duration. You must carry out this check at the correct load temperature.

Document the commissioning data

The system operating data and control settings will be required during maintenance and service. You should leave this information on site, ideally in the plant room with the equipment. Certificates for the strength and leak testing should also be left with the plant.

The system should be marked with the following information:

- Name and address of installer or manufacturer
- Model, serial number or reference/asset number
- Year of manufacture
- Number designation of the refrigerant (use the internationally recognised ASHRAE designation - avoid using trade names if possible)
- Refrigerant charge
- Oil type and designation
- Maximum allowable system operating pressures.

Make sure the customer knows all he needs to about the system

The customer should have all relevant information relating to the system. There will be actions he can take to ensure the system operates as efficiently as possible, mostly associated with good housekeeping. These include:

- Keeping the area around the air on face of air cooled condensers clear of debris
- Ensuring plant rooms are kept clear
- Good cold store door management, e.g. a frozen food store costs £6 an hour more to run if the doors are kept open. Where strip curtains are used they should not be tied back
- Loading of product so it does not impede air flow from evaporators in refrigerated cabinets and cold stores
- Ensuring refrigerated cabinets are not moved to areas where air draughts or sources of heat will affect the performance
- Ensuring equipment is not abused or mis-used.

You can list simple visual checks a user can make to ensure the system is working correctly. These could include logging the cooled space or product temperature and checking evaporators for frost build up.

You can also recommend maintenance schedules at this stage, if they have not already been prepared.

Want to know more?

There are **Good Practice Guides** published by Action Energy that will help you and your customer:

- **GPG 178**, Reducing refrigerant leakage.
- **GPG 256**, An introduction to absorption cooling
- **GPG 277**, Saving money with refrigerated appliances
- **GPG 278**, Purchasing efficient refrigeration
- **GPG 279**, Running refrigeration plant efficiently
- **GPG 280**, Energy efficient refrigeration technology - the fundamentals
- **GPG 283**, Designing energy efficient refrigeration plant
- **GPG 364**, Service and maintenance technicians guide

Copies of these can be obtained by contacting the Action Energy helpline **0800 58 57 94**. General energy information is available from **www.actionenergy.org.uk**

The **Institute of Refrigeration** has a 'Service Engineer' section which provides useful and topical information four times a year. For further information contact:

Kelvin House,
76 Mill Lane,
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